Reference System Status November 2004

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Main changes since April 2004

The current official release is version 6.3; there have been a number of β–releases since the release of 6.3. The β–release 6.3.5 is currently under testing to become official release 6.4. The main changes between the current (6.3) and the prospect (6.3.5, to become 6.4) official release are:

- Raymond filtering of orography, with consistent soil moisture and snow cover climate data (this was planned for 6.3, but due to an omission had to be postponed)
- Increased mixing in stable conditions (leading to a quicker filling of lows), rotation of the surface stress vector (leading to better near-surface winds and wind profiles in the boundary layer) and better (in general bigger) surface roughness (also to improve near-surface winds and profiles)
- Modified water vapour pressure below freezing; it reduces the amount of low clouds in cold conditions, thus allowing the temperature to drop more realistically in particular in polar conditions
- The Tanguay-Ritchie treatment of the semi-Lagrangian temperature advection (to eliminate a potential instability near orography) and smoother interpolation along the trajectory (to reduce noise)
- Important technical changes, namely the introduction of a universal Job Submission Filter; and improved data communication in the parallelized version of the model (with thanks to Jan Boerhout, NEC). The system at ECMWF was made suitable to run on the new workstations (ecgate)
- A large number of minor changes to the variational code (HIRVDA) and to the other HIRLAM components
- Revised coupling between dynamics and physical tendencies
- Revisions to the soil freezing.

Detailed description of the changes

A full list of changes is available from the release notes of the several HIRLAM versions on the HeXnet (https://hirlam.knmi.nl/UG/ReleaseNotes/). Here I will describe only the changes with a major meteorological or technical impact.

Version 6.2.2 was upgraded to official release 6.3 on 1 June 2004. At the same time, the developments after 6.2.2, as implemented in β–releases 6.2.3 through 6.2.5, were collected into β–release 6.3.1. The releases before 6.2.5 have been described in the previous HIRLAM newsletter (45).

Version 6.2.5 (13 April 2004)

Prepared for runs on the new workstations at ECMWF (ecgate, IBM).
On 1 June 2004 this version was renamed to 6.3.1.

Version 6.3.2 (7 June 2004)

Code corrections in the specification of surface properties
Correcting a number of omissions in 6.3.1.

Version 6.3.3 (28 June 2004)

Modified water vapour saturation below freezing
Colin Jones and Bent Hansen Sass described this change:
Saturation vapour pressure is now a mixed phase calculation between water and ice down to -23°C. Within the radiation routine cloud water is partitioned into solid and liquid forms using a quadratic function of local grid box temperature. Cloud water is assumed all liquid at and above 0°C and all ice below -23°C with a quadratic transition from liquid to solid in the intermediate range. Compared to the original parameterisation the new approach produces a larger fraction of solid water (ice) in a given cloud between 0 and -23°C and a correspondingly smaller fraction of liquid (water). The effect of this is to reduce cloud emissivity for clouds containing small amounts of water, thereby reducing the down-welling long-wave radiation emitted by these clouds. As a result surface temperatures in cold regions are reduced.

Modifications in the STRACO moist physics routines lead to saturation vapour pressure, with respect to pure water, being used in the calculation of all saturation variables for cloud formation. The more standard mixed ice-water saturation vapour pressure is used for calculations in grid boxes where clouds have already formed. This change causes clouds to be more difficult to initially form in cold conditions. The net result is as above, reduced emission of cloud long-wave radiation in cold conditions.

Version 6.3.4 (21 September 2004)

Physics corrections and code cleanup
Laura Rontu compiled the following list; she also cleaned up the physics code considerably.

In version 6.2.4 and later, the CBR scheme recalculates orographic roughness. However, the roughness enhancements suggested by Colin Jones did not influence all needed subroutines. Now, following a suggestion by Kai Sattler, the enhancement is done within the climate generation, to ensure consistent use throughout the model.

The combination of orographic and vegetation roughness has been updated so that orographic roughness influences only momentum fluxes. This may influence heat and moisture fluxes over mountains.

The ratio between heat and momentum roughness is limited as suggested by Sander Tijm and Bent Hansen Sass. This seems to cure a problem introduced in 6.3.3, leading to too high daytime near-surface temperatures: At high Reynolds number (much turbulence) the heat surface roughness could almost vanish, thus decoupling the surface from the atmosphere. The surface temperature would then be determined by the radiation balance. This effect has now been much reduced by limiting the ratio between momentum and heat surface roughness (in practice to something like 10). The heat roughness in the surface analysis was modified, as suggested by Ernesto Rodríguez, to match the method used in the forecast model.

The drag coefficients were modified accordingly as suggested by Bent Hansen Sass.

The stomatal resistance was increased by a factor 3 as suggested by Bent Hansen Sass and Sander Tijm.

Vertical diffusion in stable cases was made slightly smoother according a suggestion by Colin Jones.

Tanguay-Ritchie for the temperature equation
The Tanguay-Ritchie scheme treats the reference profile in a Eulerian manner and only the departure is advected by the semi-Lagrangian scheme. This eliminates a potential instability in the presence of orography. The scheme leads to a smoother discretisation of the temperature equation. The code changes also include the extrapolation along the trajectory and a smoother vertical interpolation, and thus reduce numerical noise. This code was developed by Aidan McDonald (see HIRLAM Newsletter 42) and validated by Jim Hamilton and Kalle Eerola (this Newsletter).

New job submission and archiving procedures
All HIRLAM jobs are now submitted through a Universal Job Submission Filter ("JSF"). This replaces the (mini-)SMS built-in use of job submission procedures. It results in a substantial simplification of the suite definition file template. Information items like on which host to run, or CP time limits, are now defined in a "data base". This "data base" is in fact a Perl script.

At ECMWF, almost all jobs are now run on the compute server (host “hpca”). This further simplifies the suite definition file template substantially. It also greatly reduces the risk of hitting disk limits in largish experiments, because the disks on the workstation are hardly used now anymore.

A run is now started-up by a new (mini-)SMS task. This start-up process copies all files that define an experiment (or the operational set-up) to all hosts used by the experiment.

Result files are now no longer archived in large tar-files. Rather, they are stored per file. The advantage is a much quicker inspection of file existence: there is no need to "un-tar" a large file to see whether a file has been archived. Rather, just check whether the file is there. Furthermore, files are now archived in subdirectories of the main experiment archive directory based on date and time. The archiving strategy now is the same as that used by the runs with the reference system (RCR) at FMI.

Boundary files are now generated in parallel by submitting a number of separate jobs, rather than by the earlier method of backgrounding processes from one single job.

Most of these changes are described with more detail in another article in this Newsletter.

6.3.5 (8 November 2004)

The following changes are expected to be included in β–release 6.3.5, which currently is under testing to become official release 6.4:

New rotated data sets for climate generation
Due to the homogeneous resolution over Europe and higher resolution a slightly better representation of orography and orographic roughness is obtained. The effect may be important at high resolutions (better than 10 km grid point distances). Kai Sattler presented the new data sets in HIRLAM Newsletter 45. The default is to use the data sets at 0.025º resolution, valid for the European area. For Europe, there exist also data sets at 0.0125º resolution.

Rotated stress vector and smooth and less stable mixing
By rotating the stress vector into a more geostrophic direction than the near surface wind it is possible to reduce surface friction while maintaining the filling rate of lows over land. So this rotation helps to resolve the long-standing problem in HIRLAM (and many other models) that in order to fill lows properly, the vertical diffusion has to be increased artificially, with the undesired side-effect of destroying the wind profile in the boundary layer. The rotation of the stress vector therefore can be accompanied by a reduction in vertical mixing, in particular in stable conditions. The changes and their effects are described in a number of Newsletter articles by Sander Tijm and by Bent Hansen Sass and Niels Woetmann Nielsen (this one, and HIRLAM Newsletters 44 and 45).

Physics/dynamics coupling
Isabel Martínez developed a scheme to average physical tendencies along a semi-Lagrangian trajectory. She reported about it in HIRLAM Newsletters 36 and 45. The implemented scheme averages the physical tendencies along the trajectory (by taking start and end point mean). The tendencies needed for the convection are the sum of the tendencies by dynamics, vertical diffusion and radiation, and half the tendency by convection at the previous time step. It results in slightly smoother fields, in particular precipitation; the scheme is more accurate also, and allows an increase in time step. The scheme needs more memory, to remember the tendencies of a full model state and separately the tendencies by convection only from the previous time step. The additional compute costs, mainly for the interpolation of tendencies at the trajectory departure point, are moderate, and outweighed by the allowable increase in time step.

Fix for soil freezing/inertia for spring problem
Ernesto Rodríguez developed a modification in the modelling of soil freezing, resulting in easier melting in the melting season. This allows daytime temperatures to rise much higher in Nordic spring conditions. This change is much desired for the RCR operations at FMI.

Preparations for new hardware at ECMWF
The system is being prepared for the imminent upgrade of the compute server hardware at ECMWF.

Verification plotting package
A standard plotting package for verification results. Its usage is encouraged in order to obtain directly comparable verification results of different experiments.

Postprocess vegetation roughness for momentum
To complete the range of postprocessed parameters from the model.

Code corrections
A range of (technical script) corrections and other improvements.